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COMMENTS ON THE EVIDENCE PRESENTED BY R. L. WOLFE AND C. L. BAUER FOR X-RAY INDUCED DISLOCATION GENERATION IN NaCl

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Recently R. L. Wolfe and C. L. Bauer have reported experimental results which they interpret as evidence of X-ray induced dislocation generation in NaCl.[1] The experiments consisted of subjecting one-half of a single crystal specimen to X-rays while the other half was shielded by one cm of lead. After irradiation the crystal was cleaved and etched with a suitable etchant to reveal dislocation etch pits. The crystal was found to exhibit a band or bands of high etch pit density in the protected half near the radiation interface. The bands were attributed to dislocation generation induced by the expansion[2,3] of the X-ray irradiated portion of the crystal.

It was of interest to examine specimens irradiated in the preceding manner since it is known that the cleavage process alone can produce increases in dislocation density in both uniform distributions and in "zones".[4,5] Rapid cleavage crack propagation produces relatively few new dislocations but slow and discontinuous cleavage crack propagation can account for large numbers of new dislocations.[4,5,6] Gilman, et al. have shown[7] that the nucleation of dislocations by moving cracks is velocity dependent; when the velocity is below some critical value the crack propagates in an unstable fashion leaving dense arrays of dislocations behind each time the crack slows down. Since the irradiation of only half of the

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crystal produces strain gradients due to the expansion of the irradiated half[2,3] and because the irradiation raises the yield strength,[8,9] it is reasonable to expect that the cleavage crack velocity would change in passing through the crystal. Furthermore, the largest effect would be expected in the portion of the crystal nearest the X-ray source.

In the present investigation, specimens were irradiated as specified by Wolfe and Bauer.[1] Harshaw crystals, cleaved to 2.0- by 0.5- by 0.5 cm in size were placed in a lead block so that one half was shielded by one cm of lead. Irradiations were made, for times ranging from 20 to 60 minutes, with a tungsten target X-ray tube operated at 107 kv and 5 ma. Target to specimen distance was 10 cm. The etchant used to produce dislocation etch pits was Mendelson's formulation[10] (4 g of ferric chloride per liter of glacial acetic acid).

After irradiation some specimens were chemically polished, with two parts concentrated hydrochloric acid per one part water, to remove about 2 mm of surface (the level at which Wolfe and Bauer made the etch pit observations).[1] When these specimens were etched and examined microscopically, on faces perpendicular and parallel to the incident X-ray beam direction, no evidence of high etch pit density bands was detected and no variation of etch pit density, from irradiated to protected crystal, was found. Several other polishing depths were examined on other crystals and the results were the same, i.e., no evidence of bands.

Cleavage in the fashion of Wolfe and Bauer produced in most cases results in accord with their observations although some cleaved specimens were devoid of bands. The bands obtained on cleaved crystals were approximately parallel to [100] directions, varied in width across the crystals, were diffuse on the edge away from the cleavage initiation end, and were located in the protected portion near the radiation interface.

The matching cleavage halves of a crystal displayed matching bands. When the matching cleavage halves were successively polished and etched, the density of etch pits in the bands was found to decrease with each successive polishing in the same manner as in unirradiated cleaved specimens. The etch pit density decreased in both directions instead of increasing in the direction of heavier irradiation and decreasing in the direction of lesser irradiation as would be the case if Wolfe's and Bauer's interpretation were correct.

Indications of dislocation motion during irradiation were sought by etching before and after irradiation. No evidence in the form of flat bottomed pits was found.

The results of these experiments lead to the conclusion that the dislocation bands found in irradiated crystals do not arise from irradiation per se, but rather from the effect of irradiation on the mode of propagation of the cleavage crack.

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